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METHOD FOR JOINING PIECES MADE OF THERMOPLASTIC MATERIAL

Pieces made of thermoplastic material, more particularly, sheets, are most frequently joined by gluing, especially the by the welding or hot-welding method. The heat required for hot welding is delivered in accordance with known methods by heated metal surfaces, hot gases, or by a high-frequency alternating electric current. Such methods, however, have the drawback of requiring greater quantities of material to be heated than are needed to make the joint. The undesirable heat cannot be avoided with known methods, because the welding zones heat rather slowly, and this causes heating of the material by thermal conduction in the vicinity of the welding zone. If heating is accomplished by means of hot gas or heated metal surfaces, it is often necessary to deliver the heat to the joint through at

least one of the members that are being joined. During dielectric heating, any type of material found in the alternating electric field is heated. As a result, the material not directly involved in the joining process is always and unavoidably heated. Given that the material heated to the welding temperature often possesses significantly inferior technologic properties to those of the starting material, it is desirable to limit the quantity of heated material to an indispensable minimum.

The present applicant has discovered a process for joining thermoplastic objects, more particularly, plastic sheets by the effect heat. In this process the action of the heat is almost exclusively limited to the quantity of the material for heating which is indispensable for forming the joint. According to the present invention, the required thermal energy is applied in the form of electromagnetic radiation, whose wavelength exceeds the specific absorption range of the material through which the radiation must pass in order to reach the point of junction, and the energy is transformed into heat at the point of junction by an absorber.

The applied electromagnetic radiation may have a wavelength ranging from 0.18 μ and 1mm, preferably from 0.3 to 12 μm, as a function of the properties of the material to be joined. It is advantageous to select a rather high intensity for the applied radiation in order for the heat to be transmitted

rapidly in such a way that no heating by thermal conduction occurs, except in the zone directly adjacent to the absorber. This intensity may be obtained by concentrating the space and/or the time of the radiation, for example, by focalization or by flashing. Especially suitable are radiation sources which function on the principle of stimulated emission and are referred to as lasers and mesers.

Any type of materials able to absorb incident light in a sufficiently small volume and compatible with the material to be joined, are suitable as absorbers to transform the electromagnetic irradiation into heat. Dyes or colored pigments may also be used as absorbers, especially those whose color in the visible spectrum corresponds to the complementary color of the applied irradiation. Especially suitable, however is soot black whose specific absorption is sufficiently high for the wave range being utilized.

If the joint is formed by means of a hot glue, or a heat-welded sheet is interposed, it is possible to dye the same in the same manner as the glue or the sheet.

The heat produced in the absorber may thus heat the material adjacent to the portions being joined in such a way that they can be pressure-welded, but it may also heat in an auxiliary manner, for example, a hot glue which after cooling, causes the joining portions to be joined. Pressing the portions

against one another, either simultaneously or successively, allows the assembly to be improved.

The invention is illustrated in the example below without limiting the scope of the invention:

Example 1:

In order to weld together two drawn polyester sheets, a ruby laser beam is used which is focused by means of a convergent lens on the joint to be formed between the sheets. A layer of soot disposed between these sheets, is heated by a laser flash and transmits the heat to the surrounding portions of the sheet. With a clamping tool, the sheets are pressed one against the other, and the joint is obtained by welding.

Example 2: A gas laser containing (Ar^+-laser; wave lengths: primarily 0.4880 and 0.5145 μm) is used as a light source. A light beam having a small diameter and high intensity is obtained by means of two convergent lenses whose focal distances are approximately at a 1:30 ratio and arranged in such a way that the focal points coincide and that a lens which is closest to the laser, has the longest focal distance. A line of an iron-oxide based red pigment is printed on one of the sheets to be joined. The sheets are pressed against one another, and the light beam is passed across one of the sheets in such a way that the red line is exposed without loss of radiation and is heated

by the specific absorber. A clamping device is used to press the sheets against one another at the same time and they are welded together at the site that is exposed to the light.

Example 3:

In order to weld together drawn polyethylene sheets, soot black is applied to the joints of the sheets to be connected. The points to be welded together are exposed to the radiation of a gas laser which operates on a mixture of CO_2 and N_2 by means of a focusing mirror lens. The length of the wave length of the laser is approximately 10.56 µm. In contrast to polyethylene, the soot black absorbs the radiation having these wave lengths very well and thus heats the zones adjacent to the sheets. A clamping device presses the sheets against one another and welds them together.

CLAIMS

The present invention relates primarily to:

1. A method for joining objects made of thermoplastic material, more particularly sheets, under the effect of heat; according to this method, the required thermal energy is applied in the form of electromagnetic radiation whose wave length exceeds the specific absorption range of the material through which the radiation must pass in order to reach the point of

junction, and the energy is transformed into heat at the point of junction by an absorber.

2. Embodiments as specified in the method defined in Claim 1, having the features below taken either separately or in different combinations:

a. The required energy is applied in the form of an electromagnetic irradiation, the wavelengths of which range form 0.18 µm to 1mm, and preferably from 0.3 to 12 µm;

b. The source of electromagnetic irradiation is a device which operates on the principle of stimulated emission;

c. The irradiation is focused on the zone to be affixed;

d. A dye or pigment is used as an absorber whose natural absorption is within the range of the applied irradiation.

e. The absorber is soot black.

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